REMARKS

Claims 1-16, 20, 22-53 and 57-79 were pending and stand rejected. Claims 1, 3-4, 27-28, 30-31, 53, 57-61 are amended. Claims 1-16, 20, 22-53 and 57-79 are pending.

Interview Summary

On March 16, 2009, the Examiner and the undersigned agent had a telephone conversation during which they discussed claim 1 with respect to Biswas reference. No agreement was reached. The arguments set forth during the interview are summarized below.

Response to Rejection under 35 USC §103(a)

Claims 1-18 and 20-56 and 58 under 35 USC §103(a) as being unpatentable over Biswas et al. (U.S. Patent No. 7,197,074) ("Biswas") in view of Burl (U.S. Patent No. 5,940,145) ("Burl"). This rejection is respectfully traversed.

The claimed encoding system and method selects a motion vector for a block to be encoded with reduced computational complexity while without compromising image quality compared with the cited references. As amended, claim 1 now recites (emphasis added):

> A computer readable storage medium encoded with computer executable instructions for controlling a process to perform a computer implemented method of determining a motion vector for encoding a block of a predicted video frame with respect to a reference video frame, the method comprising:
>
> establishing a size for phase correlation blocks, the size for the phase correlation blocks being larger than the maximum allowable magnitude of the motion vector;
>
> within an inner area of the phase correlation block of the predicted video frame, the inner area having a size equal to or less than the maximum allowable magnitude of a motion vector, identifying a number of highest phase correlation peaks between a phase correlation block of the predicted video frame and a corresponding phase correlation block of the reference video frame;
>
> determining for each phase correlation peak identified in the inner area, a motion

vector; and

selecting from the determined motion vectors, a motion vector that has the minimum distortion measure between the block and a reference block offset from the block by the motion vector among the determined motion vectors.

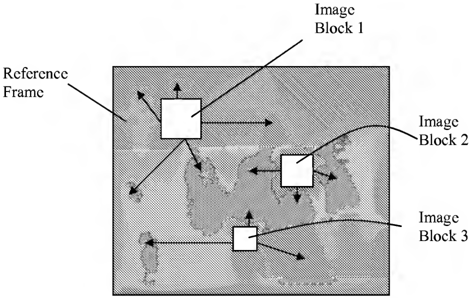
Claim 27 recites a corresponding method for frame-level motion vector determination, and claims 28 and 53 recite a corresponding circuit apparatus and circuit means, respectively.

Biswas does not disclose the elements of claim 1. First, Biswas does not disclose or teach selecting a motion vector for a block of a predicted video frame among a plurality of determined motion vectors, where the selected motion vector has the minimum distortion measure between the block and a reference block offset from the block by the motion vector. In contrast, due to the complexity of Biswas' scheme, Biswas' correlation and validation process is terminated as soon as a first candidate motion vector is found which has less than a "selected limit for error" threshold (5:62-6:5 and 7:4-11). This threshold is obviously a maximum allowable amount of error, not a minimum. Thus, by terminating with the first motion vector having less than a maximum error, Biswas does not select the motion vector that has the minimum distortion measure among the determined motion vectors as claimed.

Second, Biswas does not disclose "*within an inner area of the phase correlation block of the predicted frame, ..., identifying a number of highest phase correlation peaks between a phase correlation block of the predicted frame and a corresponding phase correlation block of the reference frame*." Examiner cited Biswas at column 4, lines 55-61 as allegedly disclosing the claimed feature. This is incorrect: The Examiner is confusing the claimed "phase correlation block" with Biswas image block. Biswas at column 4, lines 55-61 merely discloses that the size of an image block of a frame to be encoded may be smaller than its corresponding phase correlation block. This difference does not disclose identifying a

number of motion vector candidates (i.e., highest phase correlation peaks) within an inner area of the phase correlation block of a predicted video frame. Biswas treats every motion vector indicated by peaks on the correlation surface "as candidate motion vectors according to the invention." (4:49-52).

The following figure further illustrates that the size difference between a block of a frame and its phase correlation block in Biswas does not disclose the above claimed feature.



This figure illustrates a reference frame (the grey shaded area) with three exemplary image blocks of a current frame to be encoded (the three white squares). Each of the image block is in image pixel domain and has multiple motion vectors (shown as the arrows) generated by phase correlation technique. Each of the motion vectors has a length and direction, where the length represents the amount of motion the image block has moved from its reference block.

Biswas and the claimed invention both use the technique known as *Phase Correlation* in an attempt to measure the motion of objects in a frame to be encoded. The current frame to

be encoded and its reference frame (from which the current frame is to be predicted) are both broken down into a number of **phase correlation blocks**. Biswas at column 3 line 61 cites 32x32 and 64x64 as examples of sizes for these blocks. The phase correlation technique is then applied between the collocated blocks between the current and reference frames. The result of the phase correlation technique is a "**correlation surface**". As known to those of ordinary skills in the art, <u>this surface is not in the image pixel domain</u> where the current frame is to be encoded. Thus, an image block in the pixel domain is not same as a phase correlation block in the correlation surface. The phase correlation surface will have one or several 'peaks' and the *position* of each peak corresponds to a motion vector while the *magnitude* of each peak is an indication of the likelihood (probability) that that particular motion vector accurately represents the motion of objects or blocks in the image. In Biswas, each of these "peaks" is treated as a candidate motion vector (4:49-52). Thus, Biswas will evaluate <u>all</u> of these peaks in attempting to find the first one that has a distortion less than the threshold amount. In contrast, the claimed invention evaluates only those motion vectors whose peaks are with an inner area of the phase correlation block to filter out motion vector candidates are poor candidates for video compression. The result of the filtering is a group of determined motion vectors. The number of the determined motion vectors in the claimed method is obviously less than or at most equal to the number of the motion vector candidates in Biswas, because they are selected from restricted portion of the phase correlation block.

Second, to select a motion vector from a list of candidate motion vectors, Biswas and the claimed invention partition the current frame (and the current frame only) into macroblocks, blocks and sub-blocks in the image pixel domain. Biswas at column 4, lines 61-62 cites 2x2 and 4x4 as example sizes for these blocks. Each of these image blocks are

evaluated with respect to its collocated block in the reference frame. By way of explanation, this can be understood as placing each of these image blocks on top of its collocated block in the reference frame, and shifting the top block by the amount indicated by the motion vectors generated by the phase correlation processing above. The error resulting from this shift is then measured. However, Biswas selects motion vector for the block being processed that is "good enough" using a tolerance level of error (5:62-6:5 and 7:4-11), that is the motion vector whose error is just below the allowed limit. In contrast, the claimed invention selects a motion vector among a group of determined motion vector candidates and the selected motion vector has the minimum or the least distortion measure among the determined motion vectors. In other words, whereas as Biswas selects the motion vector that is just good enough, the claimed method selects the best possible motion vector, resulting in far better image quality than attainable by Biswas. Notably, this is done with significantly less processing requirements than Biswas. In simple terms: the claimed invention produces a better result at less "cost" and complexity than Biswas.

As illustrated in the figure above, there is no correlation between the size of a block to be predicted in a current frame and the amount by which the block is shifted according to its motion vectors. For example, image block 3 has a smaller block size than image block 1, but the image block 3 has a larger motion vector (i.e., the left arrow) than some of the motion vectors of the image block 1. This is because the size of image block is decided during motion vector selection process while the length and direction of motion vectors are determined by the phase correlation process. Therefore, the size difference between a block of a predicted video frame and its phase correlation block in Biswas does not disclose identifying a number of motion vector candidates within an inner area of the phase correlation

block of a predicted video frame as claimed.

Burl does not remedy the deficiencies associated with Biswas. Burl discloses a method for motion compensated image processing (Abstract). Burl discloses selecting a few of the highest peaks (e.g., 5 highest peaks) in the correlation surface (col. 2:59-65). However, similar as Biswas, Burl does not disclose *establishing a size for phase correlation blocks* and *the size of the phase correlation blocks being larger than the maximum allowable magnitude of the motion vector*. Further, Burl does not disclose or teach selecting a motion vector for a block of a predicted video frame among a plurality of determined motion vectors, where the selected motion vector has the <u>minimum</u> distortion measure between the block and a reference block offset from the block by the motion vector.

Based on the above remarks, Applicants respectfully submit that for at least these reasons independent claims 1, 27-28, 53 and 57-58 are patentably distinguishable over Biswas and Burl, both individually and in combination. Therefore, Applicants respectfully request that Examiner reconsider the rejection, and withdraw it.

The dependent claims are also patentable over the cited references, both because each depends from patentable independent claims, respectively, and because each also recites its own patentable features. Therefore, Applicants respectfully submit that claims 1-16, 20, 22-55 and 57-58 are patentably distinguishable over the cited references.

Claims 6 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Biswas in view of Burl in further view of Zhang. Claims 10-11 and 37-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Biswas in view of Burl in further view of Aude. Claims 20, 21, 47-48, and 57-58 are rejected under USC §103(a) as being unpatentable over

Biswas in view of Burl in further view of Biswas2.

Response to Rejection under 35 USC § 103(a) over Biswas in view of Burl in further view of Zhang

Claims 6 and 33 depend from their respective base claims, which are patentable over Biswas and Burl both individually and in combination. Zhang does not remedy the deficiencies of Biswas and Burl. First, Zhang's method of motion estimation is fundamentally different from the method disclosed by both the claimed invention and Biswas. Zhang searches for the best motion vector candidate by starting at a certain point, and then moving along a search path according to various criteria in pixel domain. Thus, there is no inherent limitation in how far from the starting point the search path can continue. The decision to stop at a given point (i.e., search area) is based on the amount of time the search takes and the expected compression ratio (3:20-40 and FIG. 1). The claimed invention, however, only considers motion vector candidates whose magnitudes are restricted to the noted limits ("search area") in phase correlation surface domain.

Zhang's search window is not equivalent to the phase correlation block dimensions (M and N) as claimed. In Zhang, motion estimation in frame mode and field mode is conducted in a given search range, e.g., motion vector search window, and motion displacements (e.g., motion vector magnitude) can be as large as the search window (1:36-44 and 3:40-45). In contrast, in claim 6, the phase correlation block dimensions are specifically claimed as being more than twice as large as the motion vector search window.

Further, Zhang does not disclose or teach selecting a motion vector for a block of a predicted video frame among a plurality of determined motion vectors, where the selected motion vector has the minimum distortion measure between the block and a reference block

offset from the block by the motion vector as claimed.

Thus, claims 6 and 33 are patentable over Biswas, Burl and Zhang, both individually and in combination.

Response to Rejection under 35 USC § 103(a) over Biswas in view of Burl in further view of Aude

Claims 10-11 and 37-38 depend from their respective base claims, which are patentable over Biswas and Burl both individually and in combination. Examiner depends on Aude's coherent and windowed sampling with A/D converters to reject claims 10-11 and 37-38. But Aude does not remedy the deficiencies of Biswas and Burl as set forth above.

Thus, claims 10-11 and 37-38 are patentable over Biswas, Burl and Aude, both individually and in combination.

Response to Rejection under 35 USC § 103(a) over Biswas in view of Burl and Biswas2

Claims 20, 47-48 and 57-58 depend from their respective base claims, which are patentable over Biswas and Burl both individually and in combination. Biswas2 does not remedy Biswas and Burl. Biswas2 teaches using phase plane correlation for frame rate conversion. Biswas2 uses a threshold value to evaluate the similarity between the current block of interest and its 8 neighbors (Section 3). However, this threshold is unrelated to the number of the phase correlation peaks based on a maximum allowable motion vector magnitude. Further, because Biswas2 is merely a further elaboration of Biswas (that is, Biswas2 appears to include everything in Biswas, plus additional content), the combination of these references provides nothing more than what Biswas2 alone discloses. As such, Biswas2 does not disclose the claimed features. Therefore, claims 20, 47-48 and 57-58 are patentable

over Biswas2 and other cited references, both individually and in combination.

In sum, all of the claims are patentable over all cited references, both individually and in combination.

Applicants note that narrowing amendments made in response to a previous Office Action has been reversed in this amendment. In view of the Federal Circuit's decision in *Hakim v. Cannon Avent Group PLC*, 81 U.S.P.Q.2d (BNA) 1900 (Fed. Cir. 2007), Applicants hereby rescind any disclaimer that may have resulted from the previous amendments or arguments associated therewith.

Conclusion

Applicants respectfully submit that the pending claims are allowable over the cited art of record for at least the above reasons and request that the Examiner allow this case. The Examiner is invited to contact the undersigned in order to advance the prosecution of this application.

Respectfully submitted,
DEEPIKA SRINIVASAN, ET AL.

Dated: May 11, 2009

By: /Fengling Li/

Fengling Li, Patent Agent
Reg. No. 62,962
Fenwick & West LLP
801 California Street
Mountain View, CA 94041
Tel. (415) 875-2413
Fax (415) 281-1350